WHITE PAPER

USDA Forest Service   Pacific Northwest Region   Umatilla National Forest

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Density Management Field Exercise

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Objective. This exercise demonstrates that stand density index (SDI) is easily obtained from variable-radius sample data collected in the field. A variable-radius sample is some-times referred to as 'plotless cruising' because it does not require that a circular, fixed-area plot be established. The procedure uses a basal area factor (glass prism, angle gauge, Relaskop, etc.) to select sample trees; the diameter of each sample tree is then used to calculate a basal area per tree value, along with the number of trees per acre represented by the sample tree. The field exercise illustrates this procedure.

1. Locate a plot center, and designate it by using a temporary stake and flagging.

2. Decide which basal area factor will be used for the inventory: select one that will yield an average of 4-8 tally trees per sample point.

3. Is a tree in the plot? Swing the prism (or similar instrument) in a circle, beginning from true north (just by convention), and sample all trees that are obviously "in" for the instrument being used.

4. For borderline trees, defined as those not obviously in or out when viewed with the instrument, use this process to determine if they should be tallied or not.

   a. First, use table 1 to obtain a plot radius factor (PRF) for the prism factor you are using (example: 1.944 for a BAF of 20).

   b. Measure the diameter of the borderline tree (example: 20.3 inches dbh).

   c. Multiply the dbh by the PRF to determine a horizontal limiting distance (example: 20.3" × 1.944 = 39.5 feet horizontal limiting distance).

   d. Measure the distance from the plot center (at 4½ feet above ground) to the center (side, not face) of the tree bole (at 4½ feet above ground); this is slope distance (example: 39.1 feet).

e. Measure the slope percent from the plot center (at 4½ feet above ground) to the side of the tree (at 4½ feet above ground) (example: 20 percent).

f. Obtain a correction factor from table 2 for the slope percent value you measured (example: 1.02 for 20% slope).

g. Multiply the measured slope distance by the correction factor to convert slope distance to horizontal distance (example: 39.1 feet × 1.02 = 39.9 feet calculated horizontal distance).

h. Compare the calculated horizontal distance with the horizontal limiting distance
- If the calculated horizontal distance is greater than the horizontal limiting distance, the tree is <u>out</u> and would not be tallied.
- If the calculated horizontal distance is less than the horizontal limiting distance, the tree is <u>in</u> and would be tallied.
- Example: 39.9 feet is the calculated horizontal distance for a 20.3" dbh tree growing on a 20% slope; the horizontal limiting distance is 39.5 feet, so this tree is <u>out</u> because the calculated distance exceeds the limiting distance.

5. What is the tree species? For all sample trees, record species on the plot form.

6. What is the dbh? For all sample trees, measure their diameter with a diameter tape (round off to the nearest whole inch), and record dbh on the plot form.

7. How much basal area, **per acre**, does each sample tree represent? [<u>Hint</u>: the basal area factor recorded on the top of your plot form will provide this value.]

8. What is the basal area of each sample tree, as based on its diameter? For all sample trees, record their basal area on the plot form. [<u>Hint</u>: look up the basal area value, by dbh, in table 3.]

9. How many trees, per acre, does each sample tree represent? [<u>Hint</u>: this is calculated by taking the BA per acre value (column 4) and dividing it by the BA per tree value (column 5).]

10. What is the plot's total BA per acre value? Use your calculator to sum the BA per acre values (column 4), or just multiply the total number of sample trees (column 1) by the basal area factor, and then record the result on the total line.

11. What is the plot's total Trees per acre value? Use your calculator to sum the Trees per acre values (column 6), and then record the result on the total line.

12. Calculate a quadratic mean diameter. Here's how to do this: calculate the square root of the plot's total BA per acre divided by the plot's total Trees per acre (TPA), and multiply the result by 13.54.

QMD Equation: $\sqrt{\text{Plot BA}/\text{Plot TPA}} \times 13.54$

13. Calculate a stand density index. Here's how to do this: divide the plot's QMD by 10 and raise the result to a power, and then multiply this result by the plot's total Trees per acre value. The power value is a slope factor that varies by tree species; slope factors are provided in table 4.

SDI Equation: $\text{Plot TPA} \times (\text{QMD}/10)^{slope}$

Question: Why is the plot's QMD divided by 10 when calculating SDI?

Table 1: Plot radius factors.

Basal Area Factor (BAF)	Plot Radius Factor
10	2.750
20	1.944
30	1.588
40	1.375
60	1.123
75	1.004
80	0.972

Sources/Notes: Plot radius factors were taken from Dilworth and Bell (1978), and various other sources.

Table 2: Slope correction factors.

Slope Percent	Correction Factor
0 – 9	1.00
10 – 17	1.01
18 – 22	1.02
23 – 26	1.03
27 – 30	1.04
31 – 33	1.05
34 – 36	1.06
37 – 39	1.07
40 – 42	1.08
43 – 44	1.09
45 – 47	1.10
48 – 49	1.11
50 – 51	1.12
52 – 53	1.13
54 – 55	1.14
56 – 57	1.15
58 – 59	1.16
60 – 61	1.17

Sources/Notes: Taken from various sources; many inventory or sampling references provide slope correction information in detailed, 1-percent increments.

Table 3: Basal area; and plot radius distances (feet and tenths), for various basal area factors (BAF), from plot center to center of tree (not face) at dbh and for 0% slope.

DBH (Inches)	Basal Area (Square Feet)	Plot Radius: BAF 10 (Feet)	Plot Radius: BAF 20 (Feet)	Plot Radius: BAF 30 (Feet)	Plot Radius: BAF 40 (Feet)
1	0.01				
2	0.02				
3	0.05				
4	0.09				
5	0.14	13.8	9.7	7.9	6.9
6	0.20	16.5	11.7	9.5	8.3
7	0.27	19.3	13.6	11.1	9.6
8	0.35	22.0	15.6	12.7	11.0
9	0.44	24.8	17.5	14.3	12.4
10	0.55	27.5	19.4	15.9	13.8
11	0.66	30.3	21.4	17.5	15.1
12	0.79	33.0	23.3	19.1	16.5
13	0.92	35.8	25.3	20.6	17.9
14	1.07	38.5	27.2	22.2	19.3
15	1.23	41.3	29.2	23.8	20.6
16	1.40	44.0	31.1	25.4	22.0
17	1.58	46.8	33.1	27.0	23.4
18	1.77	49.5	35.0	28.6	24.8
19	1.97	52.3	36.9	30.2	26.1
20	2.18	55.0	38.9	31.8	27.5
21	2.41	57.8	40.8	33.3	28.9
22	2.64	60.5	42.8	34.9	30.3
23	2.89	63.3	44.7	36.5	31.6
24	3.14	66.0	46.7	38.1	33.0
25	3.41	68.8	48.6	39.7	34.4
26	3.69	71.5	50.6	41.3	35.8
27	3.98	74.3	52.5	42.9	37.1
28	4.28	77.0	54.4	44.5	38.5
29	4.59	79.8	56.4	46.0	39.9
30	4.91	82.5	58.3	47.6	41.3
32	5.59	88.0	62.2	50.8	44.0
34	6.31	93.5	66.1	54.0	46.8
36	7.07	99.0	70.0	57.2	49.5

Sources/Notes: The basal area per tree values (column 2) were calculated by using the equation shown in item #5 on the bottom of page 6. No plot radius values are provided for DBHs less than 5" because it is assumed that when double-sampling, the break-point DBH would be set at 5" and trees < 5" would not be tallied. Plot radii are calculated to the center of a tree stem, not to the face of the tree. Plot radius values (R) were calculated by using this equation: $R = (DBH/12) \times \sqrt{200/BAF}$

Table 4: Slope factors for the stand density index equation (item 13), by tree species.

Tree Species	Slope Factor
Ponderosa pine	1.77
Douglas-fir	1.51
Western larch	1.73
Lodgepole pine	1.74
Engelmann spruce	1.73
Grand fir	1.73
Subalpine fir	1.73

Sources/Notes: Taken from Cochran et al. (1994).

EXAMPLE PLOT (Basal area factor = 20)

Tree Number	Species	Diameter (Inches)	BA per acre	BA per tree	Trees per acre	SDI (Dsum)
1	Ponderosa pine	22	20	2.6	7.7	31.1
2	Ponderosa pine	27	20	4.0	5.0	29.0
3	Western larch	18	20	1.8	11.1	30.7
4	Douglas-fir	29	20	4.6	4.3	21.7
5	Western larch	12	20	0.8	25.0	34.3
6	Douglas-fir	8	20	0.3	66.7	47.6
7	Western larch	14	20	1.1	18.2	32.5
8	Ponderosa pine	9	20	0.4	50.0	41.5
9	Ponderosa pine	15	20	1.2	16.7	34.2
10	Douglas-fir	16	20	1.4	14.3	29.0
		TOTAL	200		219.0	331.6

Plot QMD = $\sqrt{\text{Plot BA/Plot TPA}} \times 13.54$; $\sqrt{200/219} \times 13.54$; $.9556 \times 13.54 = $ **12.9"**

Plot SDI = Plot TPA $\times$ (Plot QMD/10)^{slope}; $219 \times (12.9/10)^{1.77}$; $219 \times 1.29^{1.77}$;

$219 \times 1.57 = $ **343.7** (when using the PP slope factor of 1.77)
321.7 (when using the DF slope factor of 1.51)
340.2 (when using the WL slope factor of 1.73)

Note: the SDI(Dsum) column shows SDI calculated by individual sample tree (slope factors were specific to each species), and then summed for the whole plot.

SDI FIELD EXERCISE PLOT FORM

Plot number _____ Basal Area Factor (BAF) _____

1 Tree Number	2 Species	3 Diameter (Inches)	4 BA per acre	5 BA per tree	6 Trees per acre
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
		TOTAL	_____		_____

COLUMN DESCRIPTIONS

1. Number sample trees sequentially

2. Tree species

3. Tree diameter (record to nearest whole inch)

4. Basal area (BA) per acre (each tally represents same amount of BA/acre as the BAF)

5. BA per tree (calculate as Pi $\times$ (DBH/24)^2, or look it up in table 3)

6. Trees per acre (TPA) = BA per acre (column 4) $\div$ BA per tree (column 5)

Plot QMD = $\sqrt{\text{Total BA/Total TPA}} \times 13.54$; Plot QMD = _____

Plot SDI = Total TPA $\times$ (Plot QMD/10)$^{\text{slope}}$; Plot SDI = _____

Appendix 1: Double Sampling (Stand Exam) Considerations

A stand examination generally uses what is referred to as a double sample – larger trees are sampled by using a variable-radius plot, and smaller trees are sampled on a fixed-area plot. A 'break-point' diameter is specified in an exam's sample design to designate a tree size separating the two plots – a break-point diameter of 5" means that all trees greater than or equal to 5" dbh will be tallied on a variable-radius plot, and all trees less than 5" dbh will be tallied on a fixed-area plot.

So, what happens if a 5.2" dbh tree is within the radius of a fixed-area plot, such as a 1/100th-acre plot, but it is too far away from the plot center to be tallied by the prism being used for the variable-radius plot – should this tree be recorded?
Answer: since this tree is greater than the 5-inch break-point dbh, the only way it can be tallied is to be 'in' on the variable-radius plot, so whether it occurs inside or outside the fixed-area plot is irrelevant.
Remember: only trees less than the break-point dbh can be tallied on a fixed-area plot, so trees larger than the break-point dbh are really invisible (ignored) when completing the fixed-area portion of a double sample.

This example demonstrates that when designing and completing a field exam involving a double sample, three primary decisions must be made –
1) Which basal area factor will be selected to sample the larger trees?
2) Which fixed-area plot size will be selected to sample the smaller trees?
3) Which break-point diameter will be used to separate small from large trees?

Variable-radius sampling makes the plot radius a function of tree diameter, so individual sample trees are selected with a probability proportional to their basal area. Or to put it another way – the plot radius varies according to the dbh of each tree. Table 3 provides plot radius values for four commonly used basal area factors (BAF). It clearly shows that the radius associated with a large-diameter tree is greater than the radius for a small-diameter tree when scanning down any of the individual BAF columns.

A variable-radius sample could be completed by measuring a tree's dbh and its distance from plot center, and then by using the limiting distance values in table 3 (by BAF) to determine if the tree is 'in' or 'out'. Although this approach certainly works, it is much slower than using a prism, angle gauge, relaskop, or similar instrument to determine if a tree should be tallied on a variable-radius plot. For this reason, the measurement approach is only used for <u>borderline trees</u> where it is not clear if they are in or out when using the instrument (prism, etc.).

During a variable-radius sample, borderline trees of diameter D[1] are tallied if they occur within the plot radius R shown in table 3:

For any given D and BAF, measured R > limiting R (table 3) = OUT (tree not tallied)

For any given D and BAF, measured R < limiting R (table 3) = IN (tree is tallied)

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[1] Most tatum aids used for stand examinations and other double sampling activities will be much more specific than what is shown in table 3 of this white paper – tree size will be shown in both inches and tenths, and the range of diameters included will span a wider gamut.

Expansion Factor

An expansion factor associated with each sample tree estimates the number of trees per acre, or the basal area per acre, that the tree represents. This factor is referred to as an *expansion factor* because rarely (if ever) is an entire acre included in the sample (for fixed-area sampling), and the concept of a fixed plot size does not pertain to variable-radius sampling anyway.

The expansion factor controls how information collected for a single sample tree will be **expanded** to a whole-acre basis. The total number of trees per acre, or the total square feet of basal area, in a stand is estimated by summing the expansion factors for all sampled trees – if 3 seedlings are tallied on a $1/300^{th}$ acre plot, then their information (size, damage levels, growth rates, etc.) is assumed to represent 900 similar trees per acre (i.e., 3 sample trees $\times$ 300 trees/acre (expansion factor for $1/300^{th}$ acre plot) = 900 trees per acre).

Note that for quick-plot stand examinations, timber cruises, and other types of rapid forest surveys, group tallying is often used. In this case, the number of sample (tally) trees may be grouped by 2-inch diameter classes (or any other grouping scheme like 4-inch dbh classes, 10-foot height classes, 4-foot-tall seedlings, and so forth), and the expansion factor would then pertain to all trees included in the group. If 6 trees are tallied in the 14-inch diameter class, and if a basal area factor of 10 was used for variable-radius sampling, then the expansion factor for the 14-inch class would be 60 (10 ft^2/tree $\times$ 6 trees = 60 ft^2).

Sampling Considerations

When designing a double sample (stand exam, etc.), the following points could be considered:

1. *Choose a basal area factor (BAF) by considering the sampling objectives.* As a rule of thumb, you'll want to pick a BAF that will provide you with an average of 4 to 8 tally trees per plot (Dilworth and Bell 1978), but 6 to 8 is actually better for many sampling objectives. Extensive experience has shown that this number of sample trees will tend to adequately characterize your stand's conditions, including variations in its species composition and stocking levels.
   Keep in mind that you cannot change the BAF from one plot to another – if your stand exam will have 10 plots, then the same BAF must be used for all 10 plots. In other words, you can't use a BAF 10 for point 1 because it yields 7 tally trees, but then switch to a BAF 20 for point 2 because staying with a BAF 10 would result in 14 tally trees! Once you pick a particular BAF, you're stuck with it for the whole exam.
   Historically, there was a period when examiners attempted to use what was called the "constant tally rule" – vary the BAF from point to point in order to get a constant number of tally trees (i.e., hold the number of tally trees constant instead of holding the BAF constant). It was quickly found, however, that this approach interjected sampling bias, and it was difficult to correct for the bias later when processing the exam. Therefore, the constant-tally approach was abandoned, and we now use the constant-BAF approach (Wensel et al. 1980).

Occasionally, you might want to go back to point 1 and start over if it becomes clear that the BAF selection was a particularly poor choice (i.e., you are only averaging 2 tally trees per plot). Note that starting over would only occur for a situation where too few tally trees were being recorded; recording too many tally trees is inefficient and results in extra work and effort (but better statistics), but too many sample trees would not be a reason to redo the exam.

2. *Choose a BAF by considering stand conditions.* If you're sampling an open stand (relatively low basal area), it would typically be necessary to use a low BAF (10 or 20) in order to average 4-8 variable-radius tally trees per plot. However, if a stand has a lot of brush, the large plot radius associated with a low BAF may make it difficult to see trees clearly enough to determine if they are in or out (a 36" dbh tree has a radius of 99 feet for BAF 10 (table 3), so it may be difficult to see its stem clearly if the stand is brushy). In this situation, a compromise may be in order – pick a larger BAF and accept fewer sample trees per plot.

3. *Choose a BAF by considering previous sampling experience on your unit.* Chances are good that previous stand exams have been completed on your unit. If you're unsure which BAF might be most appropriate for a stand, try to use historical exams for similar situations (similar forest types, stocking levels, etc.) to help pick a BAF for your stand. If historical exams have been loaded into FSVeg, then it would be fairly easy to access their sample designs and determine which BAF and fixed-area plot size was used. And if the historical exams are available in FSVeg-Spatial, then you could compare how the historical exam compares with your current stand when viewed on the same background imagery (such as NAIP, but this strategy won't work well if the historical exam occurs in an area where vegetation conditions have changed significantly since the exam occurred (such as a severe fire), and the changes are reflected on the imagery).

4. *Consider using a similar sampling objective (4 to 8 tally trees) for the fixed-area plot.* When planning for a stand examination, the distribution and abundance of regeneration can sometimes be more difficult to predict than the expected number of variable-radius sample trees. Even so, try to select a fixed-area plot size that will yield an average of 4 to 8 tally trees for the seedling-sapling size class. [Historically, not much consideration was given to selecting a fixed-area plot size because seedlings and saplings were often viewed as unimportant (no volume), but if you are going to use the exam for modeling purposes (Nearest Neighbor imputation, FVS modeling, etc.), having good information about a stand's regeneration component can be critically important.]

   For special exams where the seedling-sapling size class is a focus of the inventory (plantation stocking surveys or regeneration exams), consider an approach that might yield more tally trees than just 4 to 8. A relatively large fixed-area plot might be ideal for this sampling objective, rather than a double sample including a variable-radius plot, because a more intensive inventory may better address the specific questions associated with a regeneration exam (species composition, height growth, damage levels, etc.).

   One additional caveat: sometimes, a regeneration survey does not measure big trees, regardless of whether they are sampled with a variable-radius or fixed-area

plot. This can be problematic because although the big trees (shelterwood seed trees, for example) obviously do not qualify as regeneration, and characterizing reproduction (seedlings and saplings) is the objective of a regeneration survey, the presence of big trees can be expected to influence future stand development (by casting shade and as a source of competition) and it would be nice to know something about their characteristics as well (density, size, condition, etc.).

Basal Area Factor. A constant factor for a given critical angle (which is the angle projected from a sample point by any particular instrument used for variable-radius sampling, such as a 10-factor glass prism; all trees wider than the projected angle are tallied) (Dilworth and Bell 1978). Table 1 provides these factors for seven different critical angles. Basal area factor can also be used to refer to the number of square feet of basal area, per acre, represented by each tally tree. If eight trees are tallied at a sample point with a prism having a BAF of 10, then the basal area at this sample point is 80 square feet per acre (Wensel et al. 1980).

Variable-radius plot. In a double-sample approach, a variable-radius plot is one of two plots that share a common point center; the variable-radius plot is used to select sample trees with a probability proportional to tree size. An angle device (prism, angle gauge, relaskop, etc.) is used to project a constant angle by rotating the device around the point center in a full circle; any tree wider than the angle is tallied on this plot.

Fixed-area plot. In a double-sample approach, a fixed-area plot is one of two plots that share a common point center; the fixed-area plot is usually circular in shape and is used to sample trees that cannot be considered for sampling on the variable-radius plot. In a double-sample design, a breakpoint diameter is used to specify which trees will be considered for each of the plot types.

Breakpoint diameter. In a double-sample approach, some trees are considered for sampling on a variable-radius plot, and other trees are considered for sampling on a fixed-area plot. No tree can be tallied on both plot types for a double sample – they are mutually exclusive! In the sample design, a breakpoint diameter is used to establish a size boundary between the two plot types – a breakpoint diameter of 5 inches (most common usage) means that trees of 5 inches and greater would only be tallied on the variable-radius plot, and trees less than 5 inches would only be tallied on the fixed-area plot.

REFERENCES

Dilworth, J.R.; Bell, J.F. 1978. Variable probability sampling – variable plot and three-P. Corvallis, OR: O.S.U. Book Stores, Inc. 130 p. isbn:0-88246-030-7.

Wensel, L.C.; Levitan, J.; Barber, K. 1980. Selection of basal area factor in point sampling. Journal of Forestry. 78(2):83-84.

APPENDIX 2: SILVICULTURE WHITE PAPERS

White papers are internal reports, and they are produced with a consistent formatting and numbering scheme – all papers dealing with Silviculture, for example, are placed in a silviculture series (Silv) and numbered sequentially. Generally, white papers receive only limited review and, in some instances pertaining to highly technical or narrowly focused topics, the papers may receive no technical peer review at all. For papers that receive no review, the viewpoints and perspectives expressed in the paper are those of the author only, and do not necessarily represent agency positions of the Umatilla National Forest or the USDA Forest Service.

Large or important papers, such as two papers discussing active management considerations for dry and moist forests (white papers Silv-4 and Silv-7, respectively), receive extensive review comparable to what would occur for a research station general technical report (but they don't receive blind peer review, a process often used for journal articles).

White papers are designed to address a variety of objectives:

(1) They guide how a methodology, model, or procedure is used by practitioners on the Umatilla National Forest (to ensure consistency from one unit, or project, to another).

(2) Papers are often prepared to address ongoing and recurring needs; some papers have existed for more than 20 years and still receive high use, indicating that the need (or issue) has long standing – an example is white paper #1 describing the Forest's big-tree program, which has operated continuously for 25 years.

(3) Papers are sometimes prepared to address emerging or controversial issues, such as management of moist forests, elk thermal cover, or aspen forest in the Blue Mountains. These papers help establish a foundation of relevant literature, concepts, and principles that continuously evolve as an issue matures, and hence they may experience many iterations through time. [But also note that some papers have not changed since their initial development, in which case they reflect historical concepts or procedures.]

(4) Papers synthesize science viewed as particularly relevant to geographical and management contexts for the Umatilla National Forest. This is considered to be the Forest's self-selected 'best available science' (BAS), realizing that non-agency commenters would generally have a different conception of what constitutes BAS – like beauty, BAS is in the eye of the beholder.

(5) The objective of some papers is to locate and summarize the science germane to a particular topic or issue, including obscure sources such as master's theses or Ph.D. dissertations. In other instances, a paper may be designed to wade through an overwhelming amount of published science (dry-forest management), and then synthesize sources viewed as being most relevant to a local context.

(6) White papers function as a citable literature source for methodologies, models, and procedures used during environmental analysis – by citing a white paper, specialist reports can include less verbiage describing analytical databases, techniques, and so forth, some of which change little (if at all) from one planning effort to another.

(7) White papers are often used to describe how a map, database, or other product was developed. In this situation, the white paper functions as a 'user's guide' for the new product. Examples include papers dealing with historical products: (a) historical fire extents for the Tucannon watershed (WP Silv-21); (b) an 1880s map developed from General Land Office survey notes (WP Silv-41); and (c) a description of historical mapping sources (24 separate items) available from the Forest's history website (WP Silv-23).

The following papers are available from the Forest's website: [Silviculture White Papers](#)

Paper #   Title

Paper #	Title
1	Big tree program
2	Description of composite vegetation database
3	Range of variation recommendations for dry, moist, and cold forests
4	Active management of dry forests in the Blue Mountains: silvicultural considerations
5	Site productivity estimates for upland forest plant associations of the Blue and Ochoco Mountains
6	Fire regimes of the Blue Mountains
7	Active management of moist forests in the Blue Mountains: silvicultural considerations
8	Keys for identifying forest series and plant associations of the Blue and Ochoco Mountains
9	Is elk thermal cover ecologically sustainable?
10	A stage is a stage is a stage…or is it? Successional stages, structural stages, seral stages
11	Blue Mountains vegetation chronology
12	Calculated values of basal area and board-foot timber volume for existing (known) values of canopy cover
13	Created openings: direction from the Umatilla National Forest land and resource management plan
14	Description of EVG-PI database
15	Determining green-tree replacements for snags: a process paper
16	Douglas-fir tussock moth: a briefing paper
17	Fact sheet: Forest Service trust funds
18	Fire regime condition class queries
19	Forest health notes for an Interior Columbia Basin Ecosystem Management Project field trip on July 30, 1998 (handout)
20	Height-diameter equations for tree species of the Blue and Wallowa Mountains
21	Historical fires in the headwaters portion of the Tucannon River watershed
22	Range of variation recommendations for insect and disease susceptibility
23	Historical vegetation mapping
24	How to measure a big tree
25	Important insects and diseases of the Blue Mountains
26	Is this stand overstocked? An environmental education activity

Paper # Title
56　　Vegetation polygon mapping and classification standards: Malheur, Umatilla, and Wallowa-Whitman national forests
57　　The state of vegetation databases on the Malheur, Umatilla, and Wallowa-Whitman national forests

REVISION HISTORY

October 2014: minor formatting and text edits were made throughout the document, and a new appendix was added describing the white paper system, including a list of available white papers.